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ABSTRACT

Technological change will contribute significantly to growth in employment opportunities and wages. However, workers in specific occupations and industries may have to move among jobs and careers. Slow adoption by U.S. firms of productivity-increasing technologies is likely to cause more job displacement than their rapid adoption. New technologies are not likely to change the level of job-related skills required for the labor force as a whole. Technological change will not limit emplcyment opportunities for individuals entering the labor force with strong basic skills. The evidence suggests that (1) displaced workers who receive substantial advance notice of permanent job loss experience shorter periods of unemployment, (2) Title III of the Job Training Partnership Act does not serve the needs of many displaced workers, and (3) displaced worker adjustment assistance programs reduce the duration of unemployment and result in higher wages in new jobs. Recommendations emphasize three broad initiatives in public and private sector policies: public policies to aid worker adjustment to technological change, public policies to support the development and application of advanced technologies, and improvements in labor-management cooperation in the adoption of new technologies, as well as improvements in private managers' expertise in evaluating and implementing new technologies. (YLB)

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Executive Summary

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Executive Summary

TECHNOLOGY AND EMPLOYMENT

Innovation and Growth in the U.S. Economy

Richard M. Cyert and David C. Mowery, Editors

Panel on Technology and Employment
Committee on Science, Engineering, and Public Policy

National Academy of Sciences
National Academy of Engineering
Institute of Medicine

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Preface

In recent years, concern over the effects of technological change has led many Americans to ask whether the development and application of new technologies within the U.S. economy will create new employment or contribute to higher unemployment. Many Americans appear to be pessimistic about the answer to this question, an attitude that, if anything, has become more widespread, despite the nation's recovery from the 1981–1982 recession. The relationship of technology to employment and the effects of technological change on the workplace and on U.S. productivity have become topics of national debate in the face of slow economic growth, high unemployment, and stagnation or decline in the real (inflation-adjusted) earnings of workers since 1970. The importance of these issues to the economic welfare of all Americans, coupled with the impetus of a 1983 National Academy of Engineering symposium that revealed a range of conflicting opinions on the long-term implications of technological change for employment and a request from the Council of the National Academy of Engineering, prompted the Committee on Science, Engineering, and Public Policy (COSEPUP)[1] to initiate the current study following consultation with scholars, government officials, and business, labor, and civic leaders familiar with the employment-related effects of technology. Thus, in 1985 COSEPUP created the Panel

[1]COSEPUP is a joint committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

on Technology and Employment to carry out a new inquiry into the impact of technological change on employment opportunities, productivity, and the quality of work life (COSEPUP's charge to the panel is Appendix A).

The Panel on Technology and Employment first met in September 1985 and continued to meet at regular intervals during the next 18 months. This report incorporates the results of our discussions in panel meetings, the expertise of individual panel members, staff research and analysis, briefings from experts in industry, academia, and labor (Appendix B is a list of individuals who presented briefings to the panel or served as consultants), and the findings of the research papers commissioned by the panel (see Appendix C). A selection of these papers will be published separately in *Studies in Technological Change, Employment, and Policy* in late 1987. To disseminate our analysis and findings as widely as possible, we will also publish a summary of our report, entitled *Technology and Work in America: A Critical Challenge*.

This report addresses a number of issues that have surfaced in the debates over the employment impacts of technological change. These issues include the effects of technological change on levels of employment and unemployment within the economy; on the displacement of workers in specific industries or sectors of the economy; on skill requirements; on the welfare of women, minorities, and labor force entrants in a technologically transformed economy; and on the organization of the firm and the workplace. We have concluded that technological change will contribute significantly to growth in employment opportunities and wages, although workers in specific occupations and industries may have to move among jobs and careers. Included among our policy recommendations, therefore, are initiatives and options that can assist workers in preparing for and making such transitions.

In part because of the increased importance of international trade and competition within this economy, technological change has become essential to the preservation and expansion of U.S. employment and wages. The employment losses that result from a decline in U.S. international competitiveness are likely to outweigh any that might result from rapid technological change. Accordingly, we have developed policy recommendations to aid firms in the development and adoption of new technologies, so as to enhance their international competitiveness.

Technological and structural change pervade the U.S. economy, as they do any dynamic economic system. To ensure growth in economic opportunities for U.S. workers, technology should be viewed not as the problem but rather as a key component of the solution. With the development of policies that support investment in the human resources of this nation, as well as policies that deal with the consequences of

technological change in an equitable and humane fashion, we believe that this latest in a series of transitions to new structures of work and employment can be accomplished efficiently and fairly. In the modern world economy, there is little choice—the United States must remain at the leading edge of technology in order to preserve and improve the economic welfare of all Americans.

On behalf of the panel, I would like to thank the numerous individuals who met with us in the course of our deliberations to provide briefings and other assistance and information. We also wish to express our appreciation for the work of the panel's professional staff: Dr. David Mowery, the study director; Dennis Houlihan; Nina Halm; Sara Collins; Leah Mazade, who worked with the staff in editing the report for publication; and Dr. Leonard Rapping, the panel's study director from June 1985 through March 1986. In addition, the panel is indebted to Dr. Allan Hoffman, executive director of COSEPUP, for his unflagging support of this study since its inception and to the reviewers of our report, including the members of COSEPUP. Finally, I extend my personal thanks to the members of the panel, who served with dedication and good humor throughout this study of a difficult and extensive set of problems and issues.

Richard M. Cyert
Chairman

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Executive Summary

TECHNOLOGY AND AMERICAN ECONOMIC WELFARE

Technological change transforms the production of goods and services and improves the efficiency of production processes. It also allows the production of entirely new goods and services. Since the beginnings of American industrialization, such change has been a central component of U.S. economic growth, growth that has been characterized by the creation of new industries and the transformation of older ones as a result of innovations in products and processes. Technological advance has also played an increasingly important role in the growth of income per person during the past 100 years; its contribution to that area and to economic growth is likely to increase still further as the United States becomes more closely linked to the global economy.

The use of new technologies in production processes frequently reduces the labor and other resources needed to produce a unit of output; these reductions in turn lower the costs of production and the employment requirements for a fixed output level. If reductions in the demand for labor were the only effect of technological change on employment, policymakers addressing the problem of maintaining U.S. economic welfare would only have to balance the contributions of technological change against the costs of higher unemployment.

However, technological change has other important effects that historically have enabled society to achieve greater prosperity without sacrificing employment. By reducing the costs of production and thereby

lowering the price of a particular good in a competitive market, technological change frequently leads to increases in output demand; greater output demand results in increased production, which requires more labor, offsetting the employment impacts of reductions in labor requirements per unit of output stemming from technological change. Even if the demand for a good whose production process has been transformed does not increase significantly when its price is lowered, benefits still accrue because consumers can use the savings from these price reductions to purchase other goods and services. In the aggregate, therefore, employment often expands. Moreover, when technological change results in the development and production of entirely new products, employment grows in the industries producing these new goods. Historically and, we believe, for the foreseeable future, reductions in labor requirements per unit of output resulting from new process technologies have been and will continue to be outweighed by the beneficial employment effects of the expansion in total output that generally occurs. Indeed, the new realities of the U.S. economy of the 1980s and 1990s will make rapid development and adoption of new technologies imperative to achieving growth in U.S. employment and wages.

One crucial new reality of the U.S. economy of the 1980s is that it is more "open" to international trade than was the American economy of the 1950s and 1960s. The increased importance of trade means that higher productivity growth, which is supported by technological change, is essential to the maintenance of higher real earnings and the preservation of U.S. jobs. Moreover, the more rapid rates of international technology transfer characteristic of the modern economic environment mean that the knowledge forming the basis for commercial innovations need not be domestic in origin, just as U.S. basic research has underpinned the technological advances of firms in other nations.

The relative rates of development and adoption by U.S. and foreign industries of new process technologies affect the rates of growth in labor productivity (output per worker) in those industries and therefore can produce differences in labor costs among U.S. and foreign firms. To the extent that foreign firms develop and adopt new technologies faster than U.S. firms, the production costs of foreign producers will fall more rapidly. Barring shifts in U.S. and foreign currency exchange rates, declines in the wages of U.S. workers, or comparable technological advances by U.S. firms, these reductions in foreign producers' costs will decrease markets for U.S. firms and ultimately reduce jobs for American workers within the affected industries. To remain competitive in the absence of technological change and labor productivity growth in these industries, U.S. labor costs, relative to those of foreign producers, must be lowered, either by direct reductions in wages or through government policies that support devaluation of the dollar. Either of these methods

decreases U.S. workers' incomes relative to those of foreign workers. Thus, if U.S. firms fall behind foreign firms in developing and adopting new technologies, the alternatives are not attractive—U.S. workers must accept fewer jobs or lower earnings.

Yet, if U.S. firms consistently develop and adopt new technologies more rapidly than foreign producers, the picture is quite different. The resultant higher productivity growth in U.S. industries will support reductions in production costs, which will enable U.S. workers to retain higher-wage jobs. Because new knowledge and technologies developed in the United States now are transferred to foreign competitors more rapidly than they were in the past, however, any technology-based advantages held by U.S. firms and workers over foreign firms and workers are likely to be more fleeting in the future. A key factor in sustaining American living standards and employment thus is continued public and private investment in the generation of new knowledge. Of equal importance, however, is the need for U.S. firms to advance from fundamental knowledge to commercial innovations more rapidly than in the past.

We have defined our task in this study as that of analyzing the contribution of technological change to employment and unemployment. Because technological change plays a limited role in determining total employment, its impacts in this area are primarily sectoral in nature, and those impacts are affected only indirectly by aggregate economic conditions. We therefore regard the design of macroeconomic policies aimed at achieving high levels of aggregate demand and employment as outside this panel's charge. Despite the increased importance of international trade for this economy and the role of technological change within it, a discussion of trade policies also would have taken this panel far beyond its charge; trade policy therefore was not considered in detail by the panel.

Our principal finding may be succinctly stated:

Technological change is an essential component of a dynamic, expanding economy. Recent and prospective levels of technological change will not produce significant increases in total unemployment, although individuals will face painful and costly adjustments. The modern U.S. economy, in which international trade plays an increasingly important role, must generate and adopt advanced technologies rapidly in both the manufacturing and nonmanufacturing sectors if growth in U.S. employment and wages is to be maintained. Rather than producing mass unemployment, technological change will make its maximum contribution to higher living standards, wages, and employment levels if appropriate public and private policies are adopted to support the adjustment to new technologies.

Technological change often involves difficult adjustments for firms and

individuals. Workers must develop new skills and may be required to seek employment in different industries or locations. In many cases, workers suffer severe financial losses as a result of permanent layoffs or plant closings. Managers also face serious challenges in evaluating and adopting new manufacturing and office technologies in an increasingly competitive global economy.

Given these realities, we recommend policies to help workers adjust to technological change. Our recommendations propose initiatives to aid displaced workers through job search assistance, basic skills training, training in new job-related skills, and advance notice of plant shutdowns and large-scale permanent layoffs. Through these initiatives we focus on the need to assist individuals who experience hardship as a result of technological change and to aid them in securing new employment. We also offer recommendations that call on U.S. firms to develop and adopt new technologies more rapidly and suggest policies—both public and private—that might encourage them to do so.

The technological revitalization of American industry that is the goal of these recommendations is essential to the national welfare. The alternative to rapid rates of technological change is stagnation in U.S. wages and employment. In the end, no trade-off need be made between the goals of high levels of employment and rapid technological change. Policies that help workers and managers adjust to technological change can aid and encourage the adoption of productivity-enhancing technologies.

Technological change poses significant challenges to government policymakers, business, and labor, as well as to individual workers. Although the United States remains a technological and economic leader, the performance of this economy in adopting new technologies, achieving higher levels of productivity, and dealing with the adjustment of workers to new technologies leaves a great deal to be desired. If business, labor, and government fail to develop appropriate adjustment policies, the eventual price may be reduced technological dynamism and a decline in the international competitiveness of the U.S. economic system.

CENTRAL FINDINGS

In addition to the principal finding already stated, the central findings of this panel cover a number of dimensions of the employment impacts of technological change and form the basis for our policy recommendations, summarized below and discussed in greater detail in Chapter 10 of our full report. The complete set of findings for this study is compiled in Chapter 9.

Employment and Wage Impacts of Technological Change in an Open Economy

- *Historically, technological change and productivity growth have been associated with expanding rather than contracting total employment and rising earnings. The future will see little change in this pattern.* As in the past, however, there will be declines in specific industries and growth in others, and some individuals will be displaced. Technological change in the U.S. economy is not the sole or even the most important cause of these dislocations (see Chapters 2 and 3).
- *The adoption of new technologies generally is gradual rather than sudden.* The employment impacts of new technologies are realized through the diffusion and adoption of technology, which typically take a considerable amount of time. The employment impacts of new technologies therefore are likely to be felt more gradually than the employment impacts of other factors, such as changes in exchange rates. The gradual pace of technological change should simplify somewhat the development and implementation of adjustment policies to help affected workers (see Chapter 2).
- *Within today's international economic environment, slow adoption by U.S. firms (relative to other industrial nations) of productivity-increasing technologies is likely to cause more job displacement than the rapid adoption of such technologies.* Much of the job displacement of the past 7 years does not reflect a sudden increase in the adoption of laborsaving innovations but instead is due in part to increased U.S. imports and sluggish exports, which in turn reflect macroeconomic forces (the large U.S. budget deficit and the high foreign exchange value of the dollar during 1980–1985), slow adoption of some technologies in U.S. manufacturing, and other factors (see Chapters 2 and 3).
- *The rate of technology transfer across national boundaries has grown; for the United States, this transfer increasingly incorporates significant inflows of technology from foreign sources, as well as outflows of U.S. research findings and innovations.* In many technologies, the United States no longer commands a significant lead over industrial competitor nations. Moreover, technology "gaps" (the time it takes another country to become competitive with U.S. industry or for U.S. firms to absorb foreign technologies) are likely to be shorter in the future (see Chapter 3).

Technology and the Characteristics of Tomorrow's Jobs

- *New technologies by themselves are not likely to change the level of job-related skills required for the labor force as a whole.* We do not project a uniform upgrading or downgrading of job skill requirements in the

U.S. economy as a result of technological change. This does not deny the need, however, for continued investment and improvement in the job-related skills of the U.S. work force to support the rapid adoption of new technologies that will contribute to U.S. competitiveness (see Chapter 4).

- *Technological change will not limit employment opportunities for individuals entering the labor force with strong basic skills.* The most reliable projections of future job growth suggest that the number of jobs in the broad occupational categories accounting for the majority of entrant employment will continue to expand. Combined with a projected lower rate of growth in the entrant pool, this conclusion suggests that labor force entrants with strong basic skills (numerical reasoning, problem solving, literacy, and written communication) will fare well in the job markets of the future (see Chapter 5).

Technology and Work Force Adjustment

- *A substantial portion—from 20 to 30 percent—of displaced workers lack basic skills.* These workers often remain unemployed longer and have difficulty finding new jobs without incurring significant wage reductions. In view of the fact that technological and structural change in this economy will place increasing demands on the ability of workers to adjust, experienced workers who lack basic skills will face even greater difficulties in future job markets (see Chapter 3).
- *The evidence suggests that displaced workers who receive substantial advance notice of permanent job loss experience shorter periods of unemployment than workers who do not receive such notice.* Substantial advance notice (several months) of permanent layoffs or plant shutdowns appears to reduce the severity of worker displacement. Moreover, such a policy can improve the effectiveness of job search assistance, counseling, and retraining programs, thereby reducing the public costs of unemployment (see Chapter 7).
- *The primary federal program for displaced workers, Title III of the Job Training Partnership Act (JTPA), emphasizes the rapid placement of workers in new jobs. It does not appear to serve the needs of many displaced workers.* JTPA provides little training for the substantial number of displaced workers who need better basic skills; it also provides little extended training in job-related skills for other workers (see Chapter 7).
- *Displaced worker adjustment assistance programs reduce the duration of unemployment after displacement and result in higher wages in new jobs obtained immediately after participation in such programs.* There is limited evidence on the specific contribution of retraining in basic and job-related skills (a component of many such programs) to the employment and earnings prospects of displaced workers. Nevertheless,

it would be wrong to conclude from this that retraining is ineffective or that it has a negative impact on earnings or reemployment prospects. Too little is known about the components of effective adjustment programs for displaced worker populations with different characteristics because of the paucity of rigorous evaluations of such programs. Additional policy experiments and evaluations are badly needed to improve these programs (see Chapters 7 and 8).

POLICY OPTIONS AND RECOMMENDATIONS

Our policy options and recommendations are based on the conclusion that, with an appropriate policy structure, technological change can support growth in U.S. employment and living standards. Toward that end, we have developed options and recommendations for the public and private sectors that emphasize three broad initiatives in public and private sector policies: (1) public policies to aid worker adjustment to technological change; (2) public policies to support the development and application of advanced technologies; and (3) improvements in labor–management cooperation in the adoption of new technologies, as well as improvements in private managers' expertise in evaluating and implementing new technologies.

Although the overall U.S. standard of living and average real (inflation-adjusted) wages generally increase as a result of technological change, individuals suffer losses. Many of our public policy recommendations stem from the belief that a portion of the affluence created by technological change should be used to assist those suffering losses as a result of it. In addition, public policies that deal with the equitable distribution of gains and losses from technological change can facilitate such change by reducing the resistance of potential losers to new technologies in the workplace. Just as management policies to support adoption of new technologies within the firm must address worker concerns about adjustment and employment security (see Chapter 7 of our full report), public policies that aid adjustment can reduce potential resistance to new technologies and support their more rapid adoption. On balance, if policies are developed that will ease the burden of adjustment for those individuals faced with job loss and thereby facilitate the adoption of new technologies, all members of our society can benefit.

Recommendations for the Public Sector

Policies for Worker Adjustment

Our options and recommendations for assisting worker adjustment to technological change focus on the two groups that may be affected

adversely by such change: experienced workers who may lose their jobs as a result of the adoption of technology, and labor force entrants, whose employment prospects may be reduced by technological change. Our options and recommendations to assist experienced displaced workers focus primarily on modifications in the primary federal program for which technologically displaced workers, as well as workers displaced by other causes, are eligible, Title III of JTPA. We also suggest other policies (advance notification of plant shutdowns and large-scale layoffs) to enhance the effectiveness of Title III. Our recommendations to aid labor force entrants focus on the need for additional research and actions based on the reports of other expert groups, a decision that reflects the fact that a complete evaluation of policies affecting the educational attainment and basic skills preparation of entrants is beyond the scope of this report. Our public policy recommendations also address the impacts of technological change on the employment prospects for minority and female members of the labor force.

Options for Adjustment Assistance for Displaced Workers

We recommend that action be taken to improve existing JTPA Title III programs of job search and placement assistance and training in both basic and job-related skills for displaced workers. We recommend that some or all of the following options be implemented:

- *broadening the range of employment services provided to displaced workers and those facing imminent displacement, including job counseling, skills diagnosis, job search assistance, and placement services;*
- *increasing the share of Title III funds devoted to training in basic and job-related skills;*
- *broadening income support for displaced workers engaged in training;*
- *instituting a program of federally provided direct loans or loan guarantees, administered by state or local authorities, to workers displaced by technological change, plant shutdowns, or large-scale layoffs (these loans could be used by displaced workers to finance retraining or relocation or to establish new businesses); and*
- *establishing a program for demonstrations and experiments with rigorous evaluation requirements to test and compare specific program designs.*

In addition to these modifications to JTPA, we recommend revising state unemployment compensation laws to guarantee explicitly that displaced

workers who are eligible for unemployment compensation can continue to receive benefits while undertaking retraining.

We have concluded that the federal government should be the primary source of funding for the abovementioned policy options. Federal financing is preferable to state funding because of the inequities created by differences in the level of state resources for such programs. Indeed, states that are experiencing severe economic dislocations are likely to face serious problems in funding significant displaced worker programs. In view of the fact that one of the central motives for worker adjustment programs is the equitable distribution of the costs and benefits of new technology adoption among the U.S. population, the avoidance of regional inequities is an important consideration. One option for financing the economic adjustment loans, like the arrangements for other federal loan programs, would employ the Federal Financing Bank and therefore would not require federal funds from general revenues.

Estimates of the costs of these adjustment assistance options for displaced workers depend on estimates of the population of displaced workers. In Chapter 3, we note that estimates of the number of workers displaced annually range from 1 million, if displaced workers are defined as individuals with 3 years' employment in their jobs prior to layoff, to 2.3 million. Cost estimates also depend on assumptions about the rates of worker participation in such programs, an area in which reliable data are scarce. Existing programs that combine income support with retraining for displaced workers, such as the UAW-Ford program, have enrolled 10–15 percent of the eligible population (see Chapter 7). Although we lack conclusive evidence on this point, it may be that participation rates would be higher in programs involving displaced workers from industries that pay lower wages than the automotive industry.[1]

We have compiled estimates of the costs to the federal government of job search assistance, training, and extended unemployment compensation for two values of the annual flow of displaced workers (the two values are drawn from the 1984 survey of displaced workers conducted by the U.S. Bureau of Labor Statistics): 1 million workers, which is the estimated number of displaced workers who had been employed for 3 or more years in the job from which they were displaced; and 2.3 million, which is the estimated total number of workers suffering permanent job loss. As estimated rates of participation in these programs range from 5 to 30 percent of the displaced worker population, the estimated costs of these policy options range from $131 million (5 percent participation rate)

[1]Participation rates also will be affected by the policies and guidelines adopted by states in administering any system of training, job search assistance, and income support.

to $786 million (30 percent) for an annual flow of 1 million displaced workers. It is important to note that the highest estimated participation rate exceeds any observed thus far in a displaced worker training program in the United States. If we assume that the flow of eligible displaced workers is 2.3 million annually, the estimated costs of the program range from $301 million (5 percent participation rate) to about $1.8 billion (30 percent).[2] JTPA Title III outlays for fiscal year 1987 are roughly $200 million, although a significant expansion has been proposed in the President's budget for fiscal year 1988.

How could these policy options be financed? The panel discussed revenue alternatives and found no single method that was preferable to all others on equity and other grounds. In the absence of evidence suggesting that one alternative is superior to all others, the decision on funding sources and budgetary reallocations is properly political, involving considerations that extend well beyond this panel's charge.

Advance Notice of Plant Closures and Large Permanent Layoffs[3]

We have concluded that substantial (a minimum of 2–3 months) advance notice of permanent plant shutdowns and large permanent layoffs offers significant benefits to the workers who are displaced and to the nation by reducing the average duration of the workers' unemployment and lessening the public costs of such unemployment. The current system of voluntary advance notice, however, fails to provide sufficient advance notice to many U.S. workers. We therefore recommend that federal action be taken to ensure that substantial advance notice is provided to all workers. Although the panel agreed on the need for federal action to broaden the coverage of advance notice within the U.S. work force, panel members were not unanimous in their support of a specific legislative or administrative mechanism to achieve this goal. The panel believes that the following alternatives are viable options to achieve broader advance notice, with appropriate provisions to reduce the burden on small business and provide for unforeseen circumstances:

- *federal action to require employers to provide substantial advance notice of permanent plant shutdowns and large permanent layoffs; or*

[2]If the annual flow of displaced workers is estimated to amount to 1.2 million workers (the estimate used by the Secretary of Labor's Task Force on Economic Change and Dislocation, 1986), the estimated costs of these options range from $157 million to $943 million.

[3]Panel member Anne O. Krueger dissents from this recommendation. Her statement appears at the end of the Executive Summary and in Appendix D of the full report.

• *federal action to provide tax incentives for employers to give such notice.*

The current system of voluntary advance notice does not provide workers with the "best-practice" amount of advance notice (a minimum of 2–3 months)—as Chapter 7 notes, too few workers are notified in advance of permanent plant closures or large permanent layoffs, thus hampering their adjustment. When workers receive sufficient advance notice, the evidence suggests that they adjust more rapidly and more successfully to job loss, which reduces the costs of displacement to them and to the public sector. We believe that the benefits of advance notice more than outweigh the costs of such a policy—costs that exist, but that are distributed differently, when no advance notice is provided. When advance notice is given, the costs of worker displacement are shared by taxpayers, by the displaced workers, and by the firms closing plants or permanently discharging workers, rather than being borne primarily by taxpayers and the workers being laid off.

Through its public policies, this society has made a judgment that the costs of many regulations (e.g., those covering health and safety, consumer protection, or securities markets) that enhance the flow of information to workers and consumers and distribute costs more equitably among workers, consumers, and firms are more than offset by the benefits of such policies. We believe that advance notice falls into the same category of public policy and that steps to mandate this practice should be taken by the federal government.

Training for Labor Market Entrants

We share the concerns of other studies, set forth in the reports of the COSEPUP Panel on Secondary School Education for the Changing Workplace ("High Schools and the Changing Workplace: The Employers' View," 1984), the Task Force on Teaching as a Profession, of the Carnegie Forum on Education and the Economy ("A Nation Prepared: Teachers for the 21st Century," 1986), and the U.S. Department of Education ("A Nation at Risk: The Imperative for Educational Reform," 1983), regarding the amount and quality of basic skills preparation provided to labor force entrants by U.S. public schools. Improvement in the basic literacy, problem-solving, numerical reasoning, and written communication skills of labor force entrants is essential. We endorse additional public support for research on strategies to achieve this goal, as well as financial support for the implementation of programs that improve the basic skills of labor force entrants and of those already in the labor force who lack these skills.

Equal Employment Opportunity

We recommend more vigorous enforcement of policies to combat racial and sexual discrimination in the labor market as a means of improving the ability of minority and female workers, as well as minority and female labor force entrants, to adjust to the demands of technological change.

Science and Technology Policy to Support the Adoption of New Technologies

We support continued high levels of investment by industry and the federal government in basic and applied research—this is the essential "seed corn" of innovation, and such investments play a significant role in the education of scientists and engineers. Federal support for nondefense R&D is particularly important, in view of the limited commercial payoffs from the high historical levels of defense R&D in this country (there are important but limited exceptions to this generalization, as noted in Chapter 2). The foreseeable contribution of defense R&D to the civilian U.S. technology base appears to be limited at best.

In addition to a strong research base, however, public policies to support more rapid adoption of new technologies within this economy deserve consideration. The historic focus of post-World War II science and technology policy on the generation rather than the adoption of new civilian technologies (once again, a generalization with several important exceptions) contrasts with the orientation of public science and technology policy in several other industrial nations (e.g., Japan, Sweden, and West Germany) and may have contributed to more rapid adoption of manufacturing process innovations and more rapid commercialization of new product technologies in those nations. We therefore support the development and evaluation of additional public policies to encourage the more rapid adoption of new technologies within the United States.

We recommend increased federal support for activities and research to encourage more rapid adoption of new technologies. Although the achievement of this goal requires actions in a number of areas not considered by this panel, our review of policies leads us to recommend the following options for consideration:

- *Strengthen research on technical standards by public agencies (primarily the National Bureau of Standards) to support, where appropriate, private standard-setting efforts.*
- *Strengthen research programs supporting cooperative research be-*

tween industry and the federal government in the development and application of technologies.

- *Increase support for federal programs to improve U.S. firms' access to foreign science and engineering developments and innovations.*

The Adequacy of the Data

In the course of this study, the panel has found that the data available from public sources are barely sufficient to analyze the impacts of technology on employment. In some cases this data problem reflects the rapid expansion of new sectors of the economy, such as services, for which federal agencies have been hard-pressed to monitor and collect data comparable in quality and quantity to those available for manufacturing. In other cases these data have declined in quality during the past decade as a result of reductions in data collection budgets. The amount and quality of data on evaluations of worker adjustment assistance programs also must be improved.

- *We recommend that post-fiscal year 1980 reductions in key federal data collection and analysis budgets be reversed and that (at a minimum) these budgets be stabilized in real terms for the next decade in recognition of the important "infrastructural" role data bases play within research and policymaking. We urge that a portion of these budgets be devoted to improvements in the collection and analysis of employment, productivity, and output data on the nonmanufacturing sector of this economy.*
- *We recommend that a new panel study or a supplement and follow-up to the Current Population Survey be undertaken by the Bureau of Labor Statistics to examine the effects of technological change on the skill requirements, employment, and working conditions of individuals of working age. We also support the development by the Census Bureau of better data on technology adoption by firms.*
- *We recommend that the Bureau of Labor Statistics expand its survey of displaced workers (the special supplement to the Current Population Survey) to allow annual data collection and that this survey improve its question on the nature and effect of advance notice of layoffs.*
- *We recommend that any expansion of adjustment assistance services for displaced workers be accompanied by rigorous evaluations of these programs to provide information on the long-term effectiveness of different program designs and strategies.*

To reduce the potential for conflicts of interest that may arise when an organization charged with operating adjustment assistance programs has sole responsibility for the design and administration of evaluations of these programs, we recommend that federal or state agencies responsible

for the operation of such programs share with other agencies the responsibility for evaluating them, or conduct such evaluations with the advice of independent expert panels.

- *We recommend that evaluations be undertaken of the implementation of the provisions of the Perkins Vocational Education Act of 1984 that allow federal and state funds to be used for improving the skills of the employed work force. In addition, a federally sponsored evaluation of a sample of state-level programs in upgrade training should be undertaken to determine the overall effectiveness of such programs and the specific design features that contribute to success.*

Health and Safety Impacts of Technological Change

We recommend a major interdisciplinary study of the consequences of technological change for workplace health and safety and the regulatory structure designed to ensure that worker health and safety are protected. These areas also should be monitored carefully by federal and state agencies.

Recommendations for the Private Sector

Labor–Management Collaboration in Technology Adoption

Rates of adoption of new technologies, as well as the exploitation of computer-based manufacturing and office automation technologies to increase worker productivity, satisfaction, and safety, are affected significantly by the management of the adoption process. If the process proceeds smoothly, both workers and management can benefit from these technologies, which have the potential to enrich work as well as to enhance its efficiency. The potential payoffs from cooperation between labor and management in technology adoption are high, but such cooperation has been lacking in some U.S. industries. Our recommendations in this area highlight some key components of successful adoption strategies.

Elements of "Best-Practice" Strategies for Technology Adoption

- *We recommend that management give advance notice of and consult with workers about job redesign and technological change.*

- *We recommend that the adoption of new workplace technologies be accompanied by employment policies that strengthen employment security; such policies include retraining of affected workers for other jobs and a reliance on attrition rather than on permanent layoffs wherever possible. At the same time, workers and unions must recognize their stake in a more productive workplace and consider modifications of work rules and job classifications in exchange for such employment security policies.*

Protection from the Costs of Displacement

We recommend that management and labor explore the use of severance payments for permanent layoffs of experienced workers. To preserve such benefits in the event of a firm's bankruptcy, we also recommend that employers and workers consider establishing a joint insurance fund.

Education for Managers

We recommend that the current efforts to strengthen the quality of managerial education in the management, adoption, and evaluation of advanced manufacturing and service production processes be continued, both within business schools and through other institutions. Additional research on this topic is needed and could be funded through university–industry research collaboration, among other possibilities. Education for those currently employed as managers also must be strengthened to incorporate instruction in the adoption of new technologies and in strategies for helping the work force adjust to technological change.

Statement of Anne O. Krueger

Advance notification of layoffs is undoubtedly beneficial to those workers who will lose their jobs. If there were no negative side effects associated with advance notification, it would clearly be beneficial to all.

There will be several side effects, however, if notification is mandatory. First, the necessary enforcement apparatus would increase the cost of doing business. Second, for all firms, but especially for risky ones, knowledge that layoffs could not be made on short notice would increase incentives to use capital and hire fewer workers. To the extent that fewer jobs would be created, the proposed requirement would hurt the employment prospects of those the proposal is designed to assist. That mandatory periods prior to layoffs can result in smaller levels of employment has been well documented in a number of developing countries. Third, requirements of advance notification reduce the flexibility of firms already in difficulty. The requirement is, in effect, the same as a tax for these firms.

I conclude that advance notification is desirable, and efforts to educate employers of its value to employees should be encouraged. With respect to mandatory notification, however, I believe that the evidence is far from sufficient to warrant such a step.

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